

Presentation to Brookhaven Workshop 9th and 10th May 2007

E H Perrott NUKEM Limited

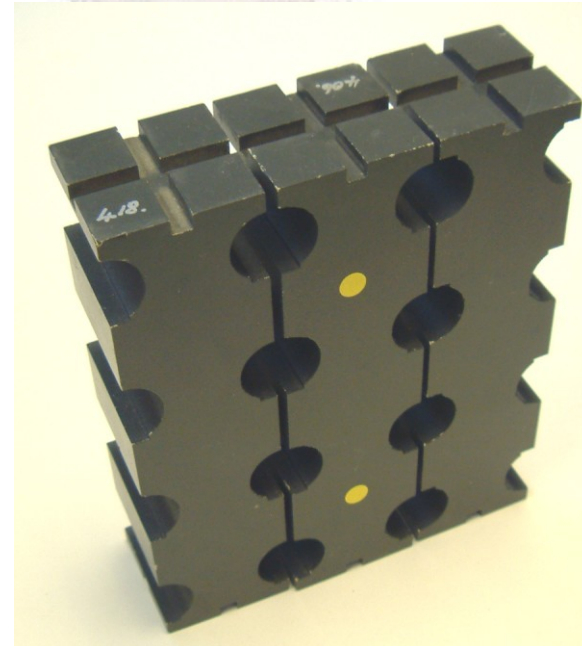
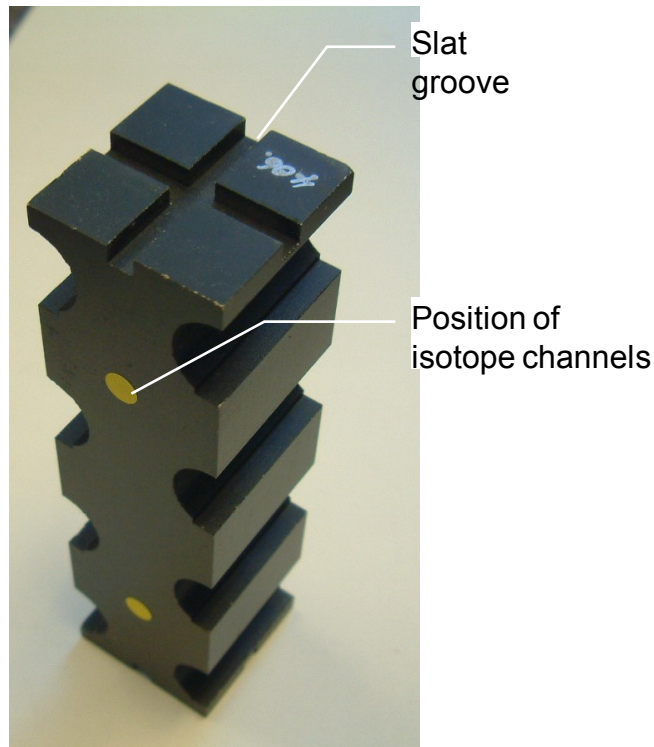
Pile 1 Foil Hole Inspections



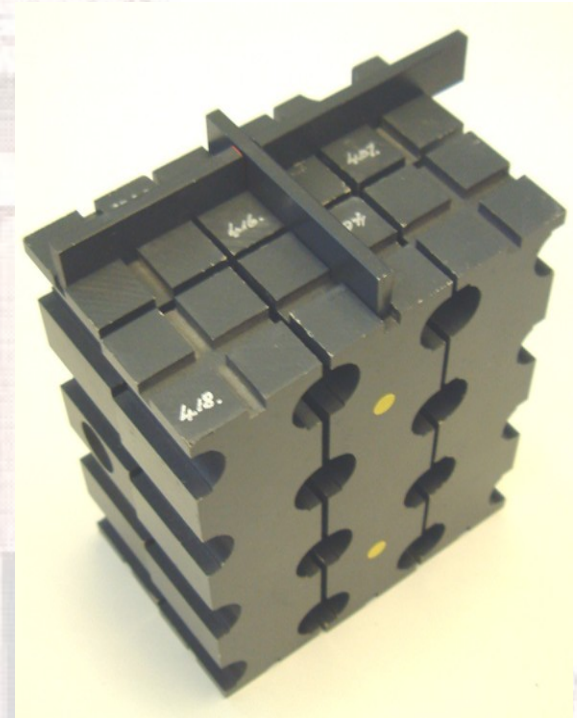
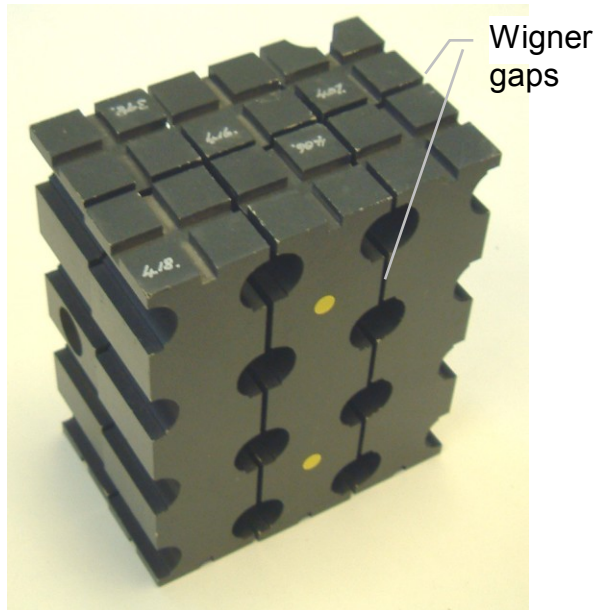
Pile 1 Foil Hole Inspections

The core structure

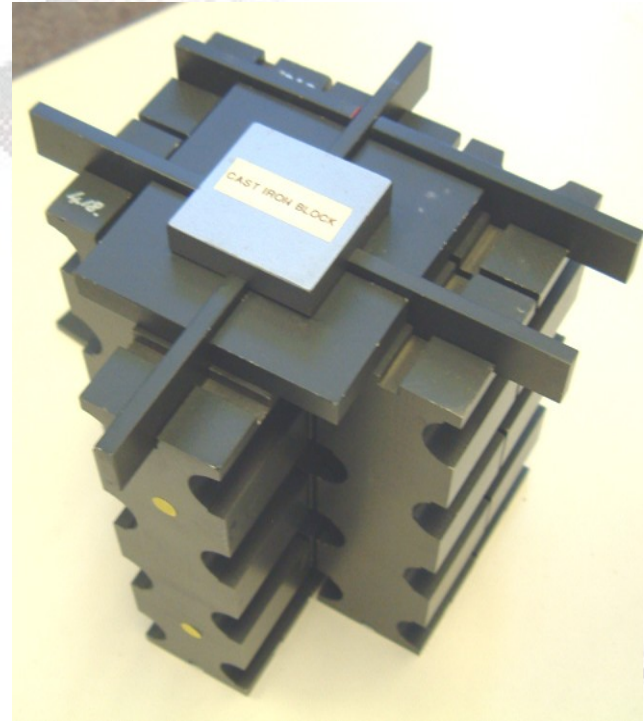
Horizontal channels and vertical penetrations are formed by the profile of adjacent graphite bricks



A Single full height pile 1 graphite brick on the left with three bricks together on the right showing how the pile horizontal fuel channels are formed



Three further blocks added to show the slat groove arrangement at the top of the blocks. On the right three slats have been added



Two tiles are added to show their positioning. On the right a further block and further tiles and slats added allowing the location of cast iron top tiles to be shown.

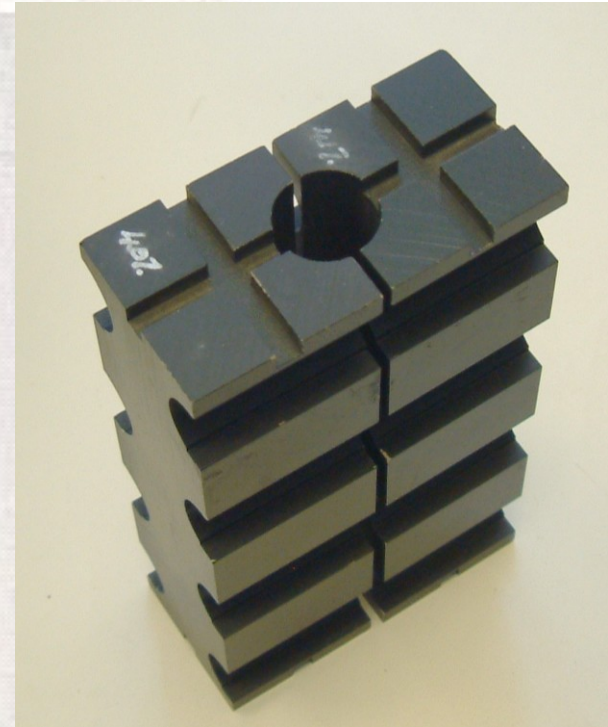
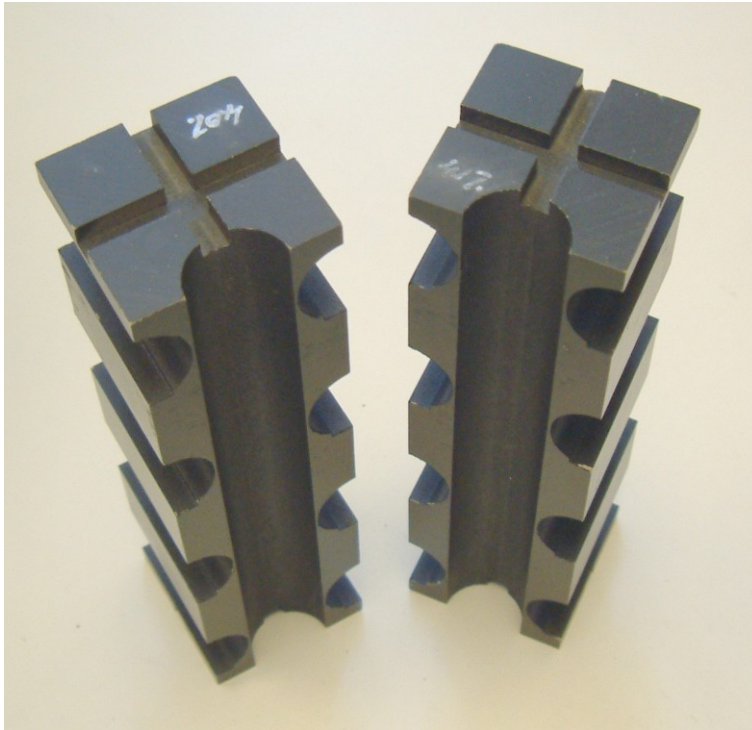
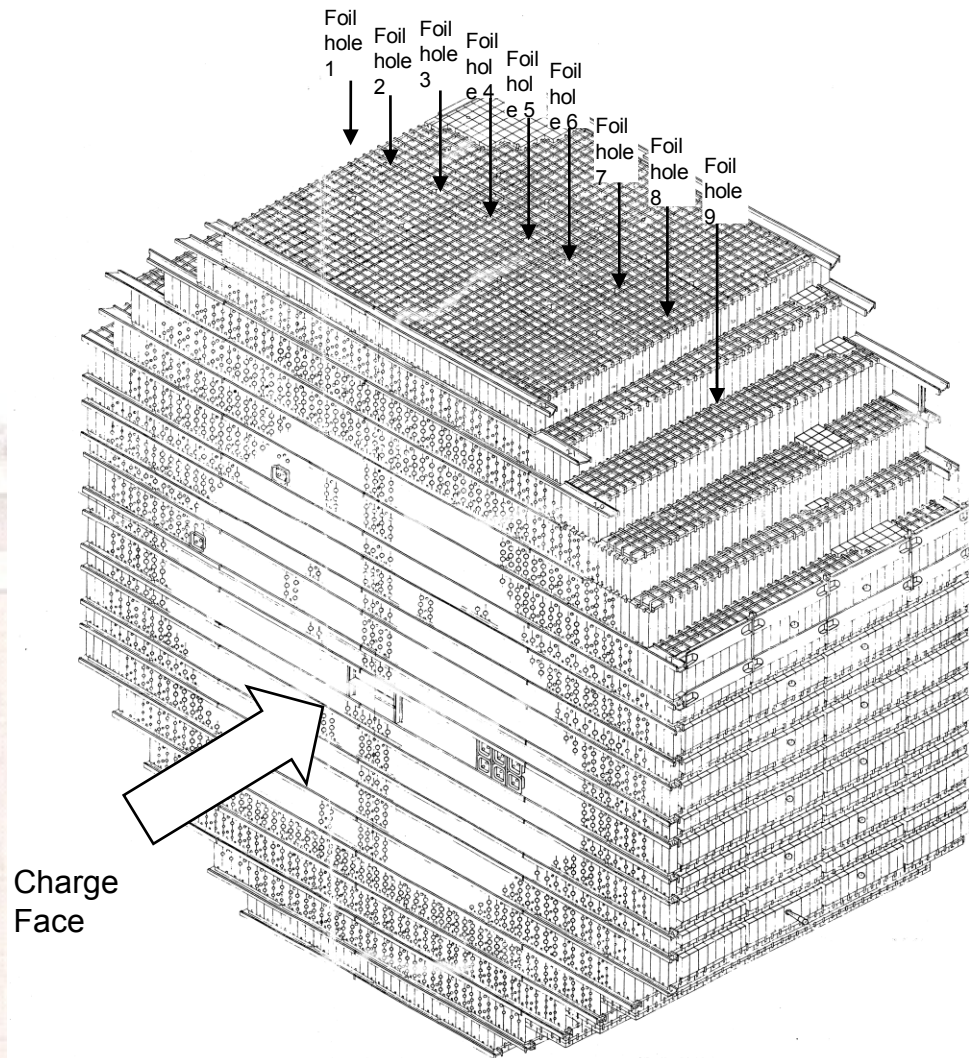
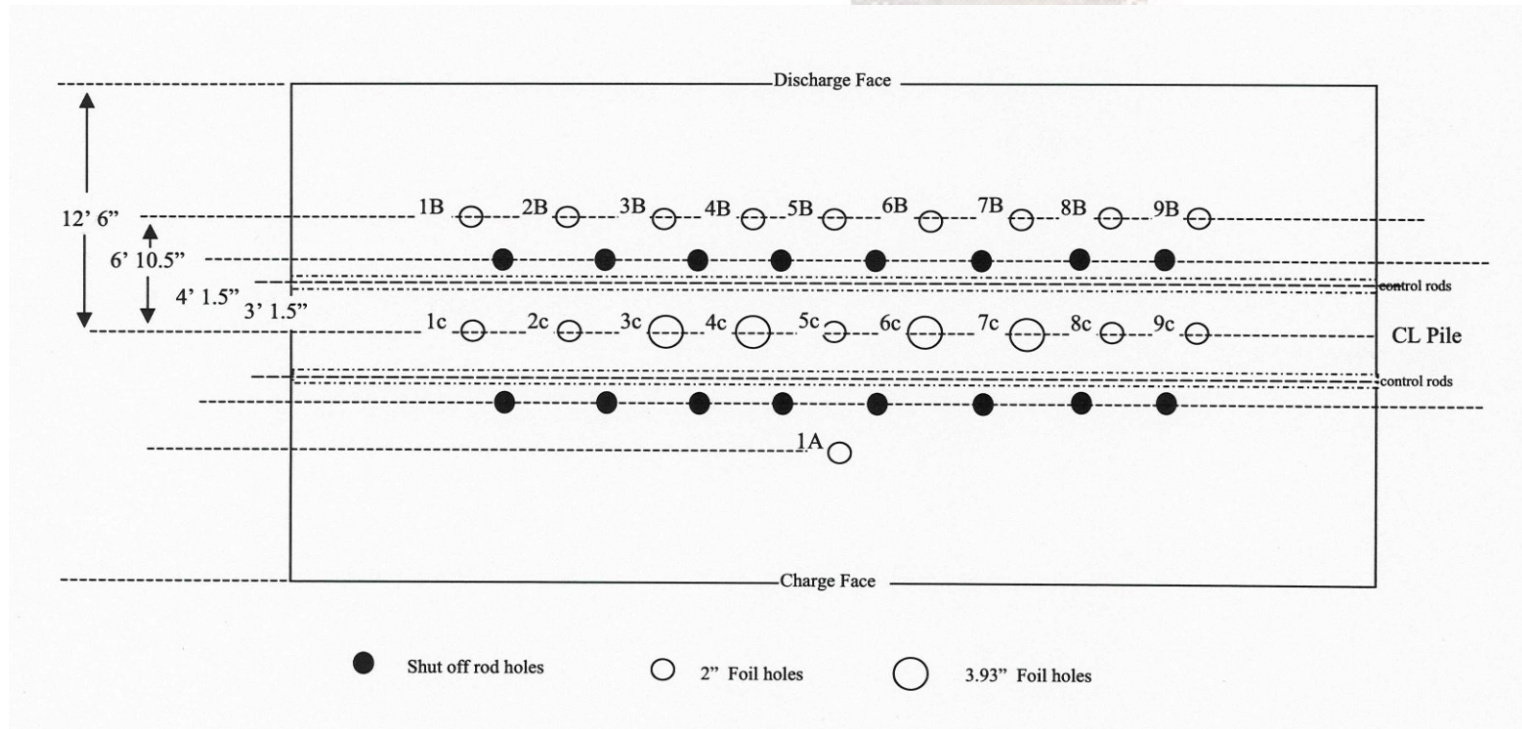
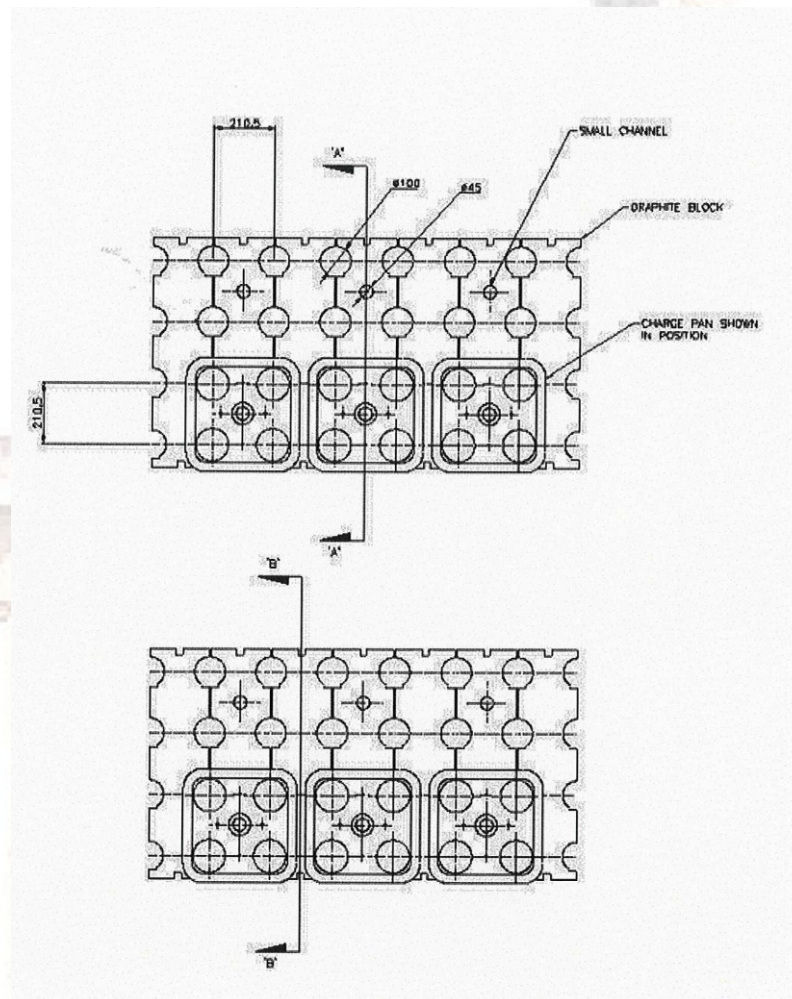


Diagram showing how two machined blocks go together to form a vertical foil hole

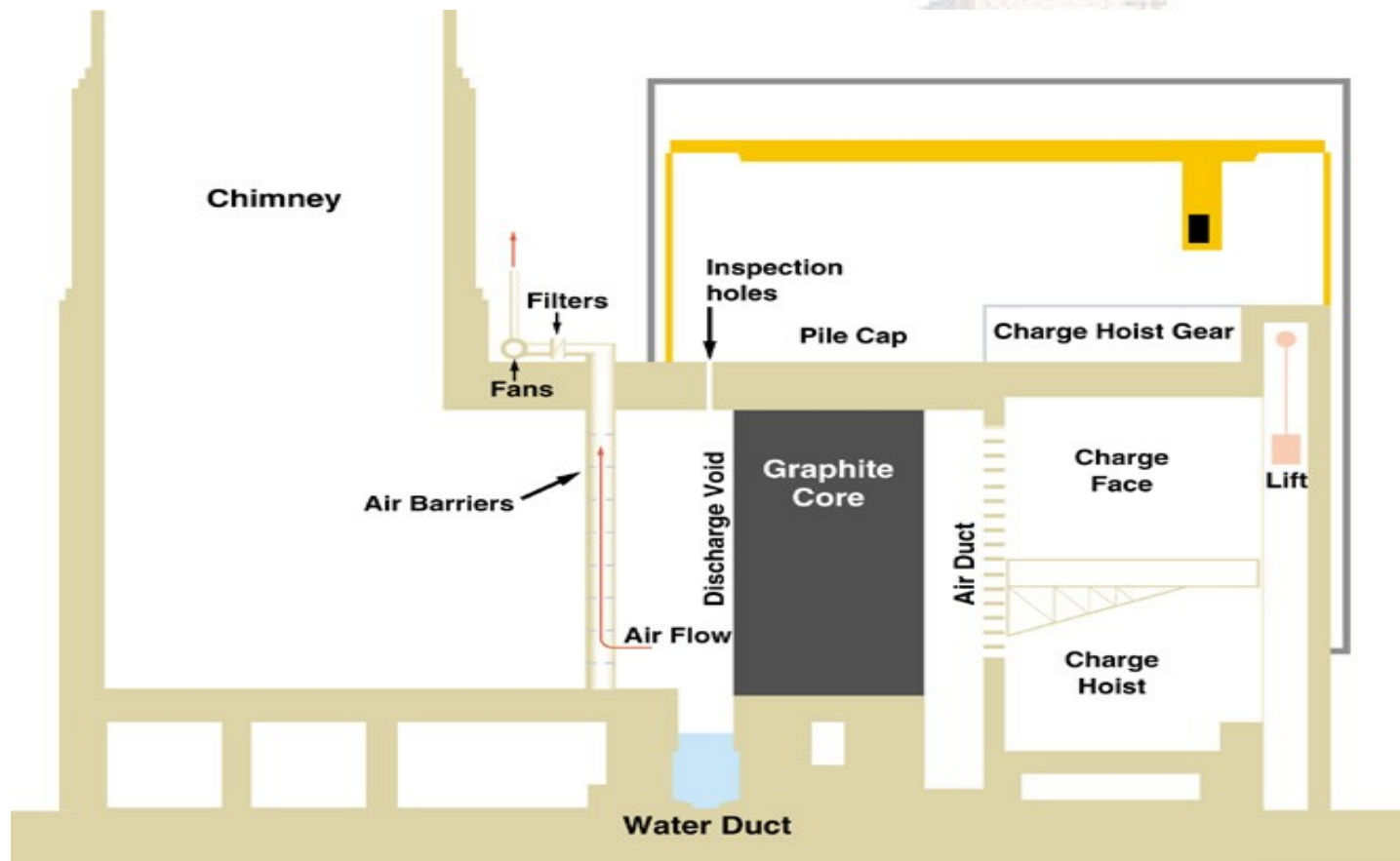




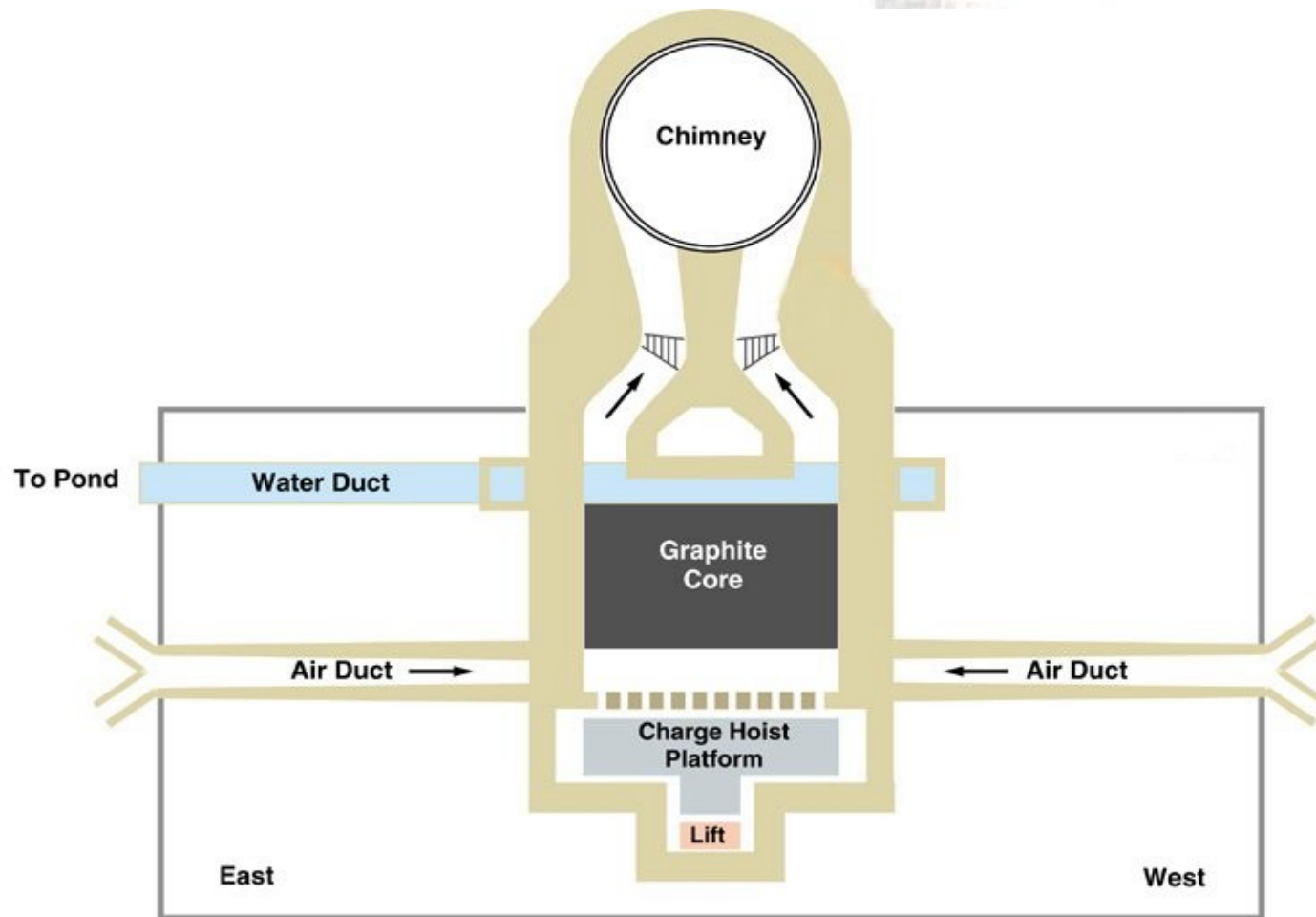
Arrangement of vertical core penetrations from the pile cap



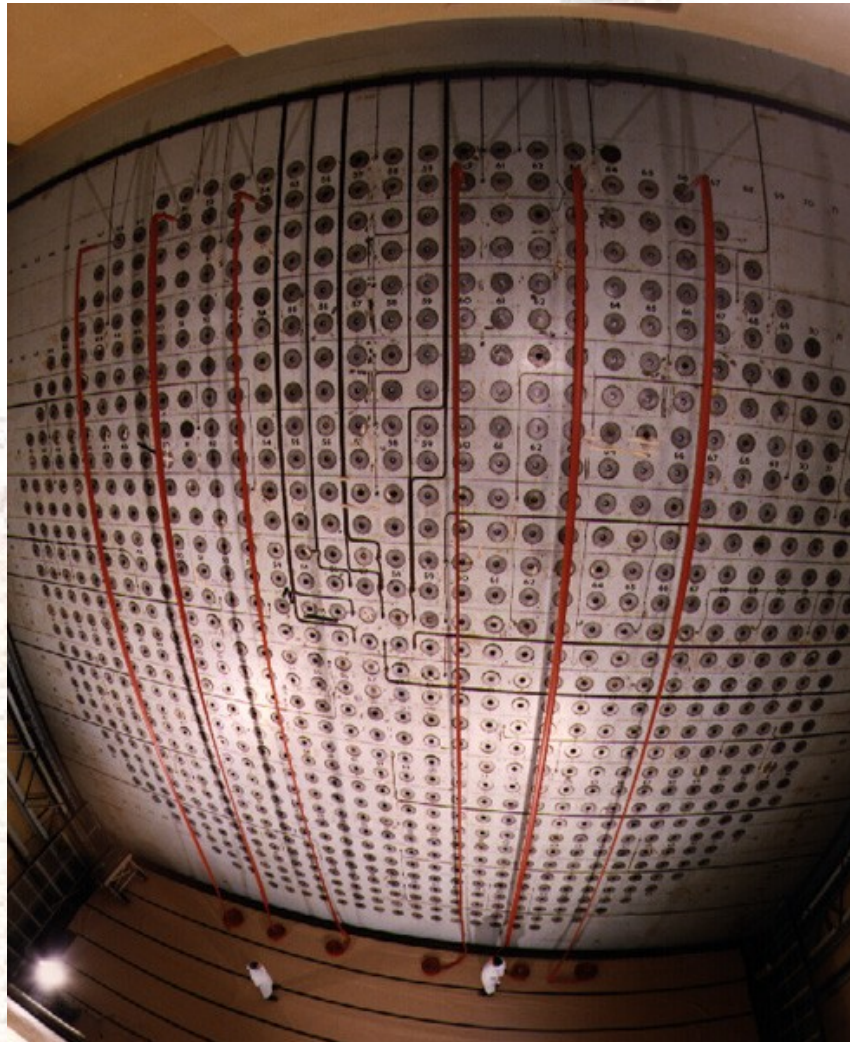
Charge face charge pan layout



Side Elevation pile 1



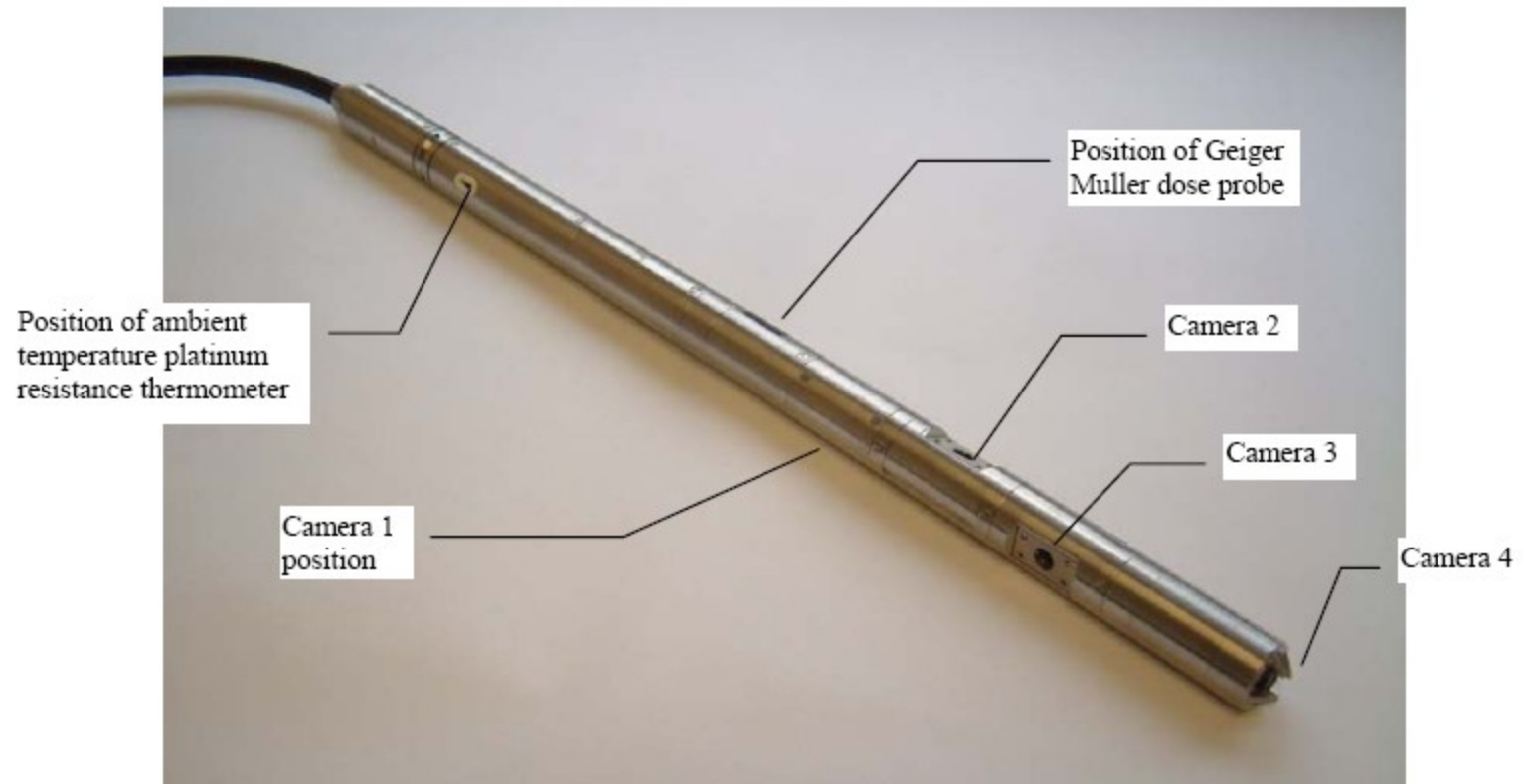
Plan view of pile 1



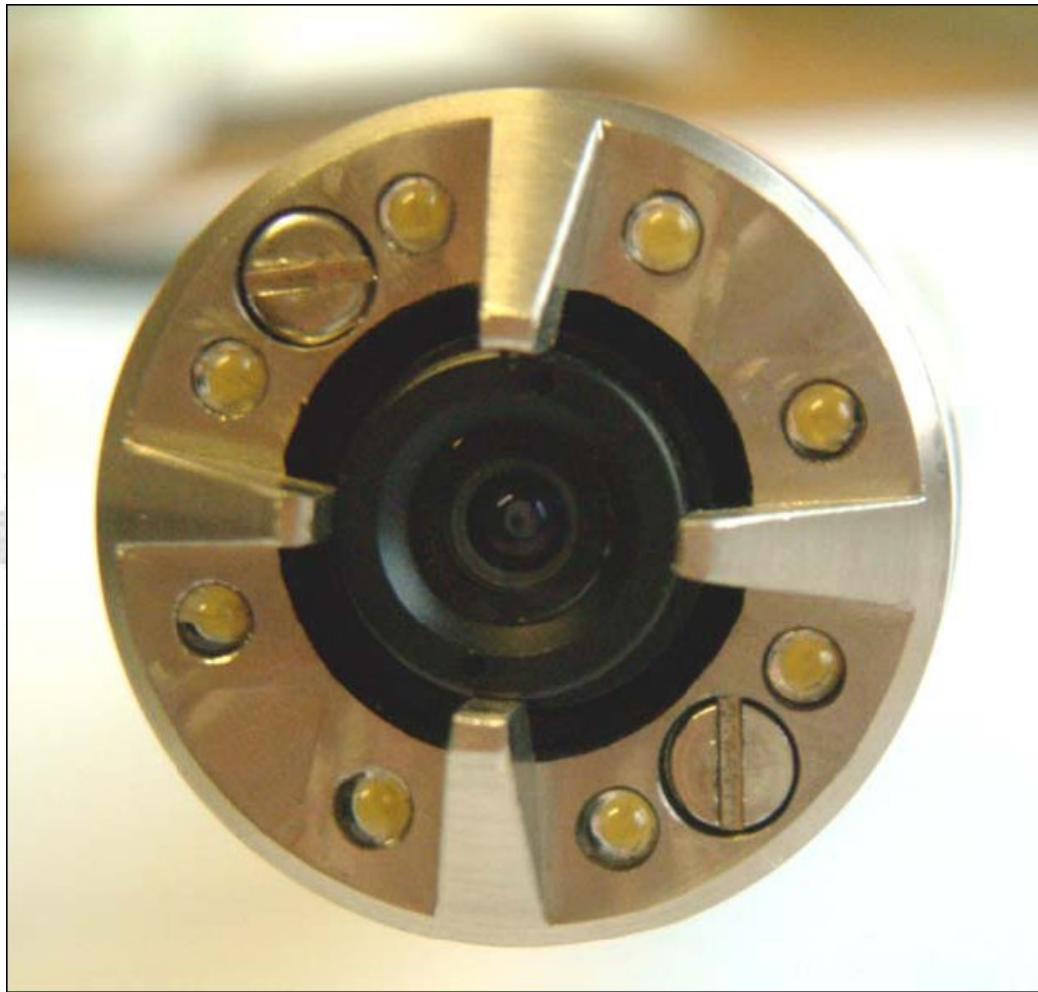
Pile 1 Charge face

Pile 1 Foil Hole Inspections

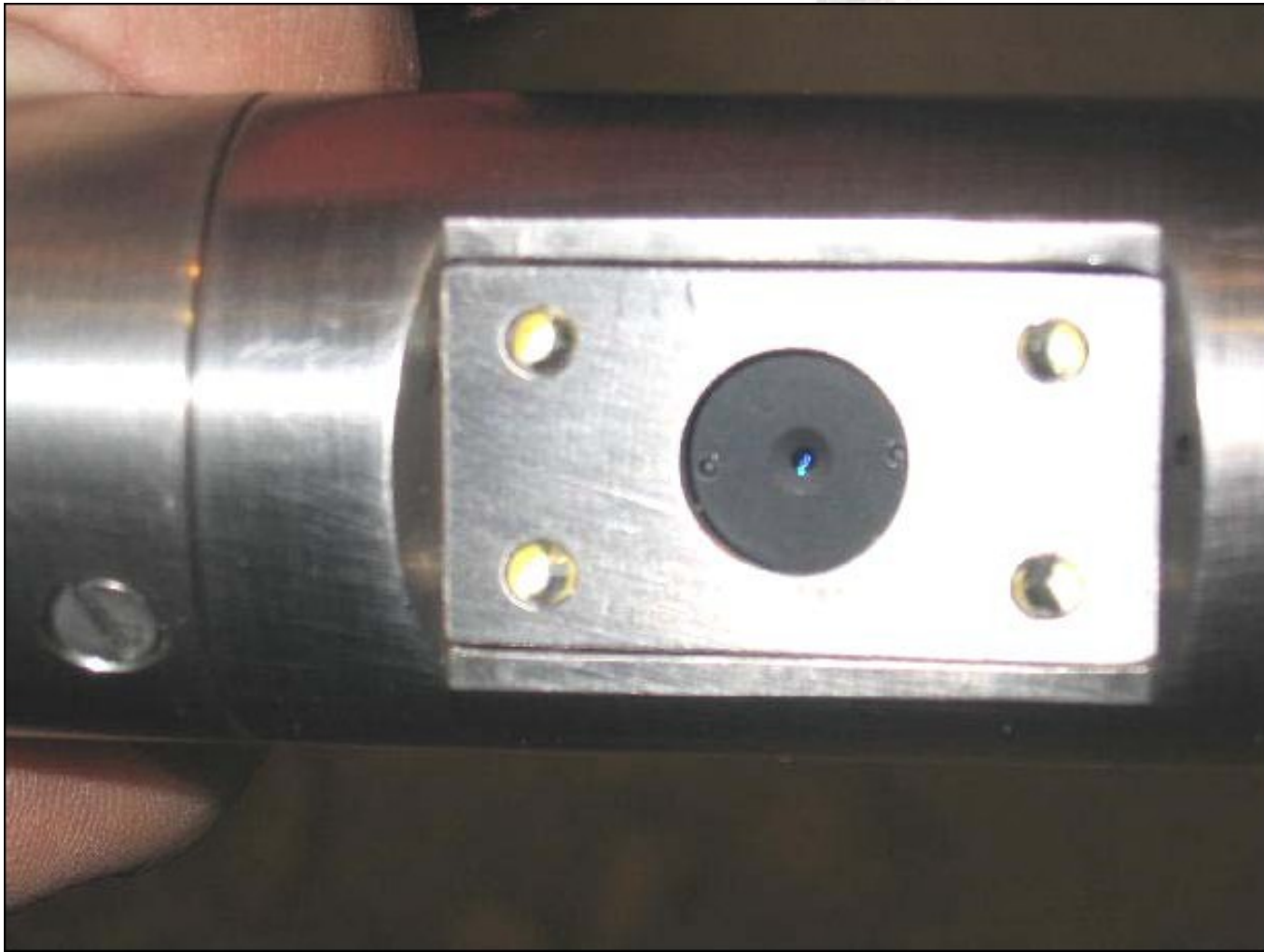
The Probe design



The foil hole inspection probe



Camera 4, the forward facing view with 8 LED lights.



One of the side view cameras and its four LED lights

Pile 1 Foil Hole Inspections

The Surveys



The survey equipment in place over foil hole 9

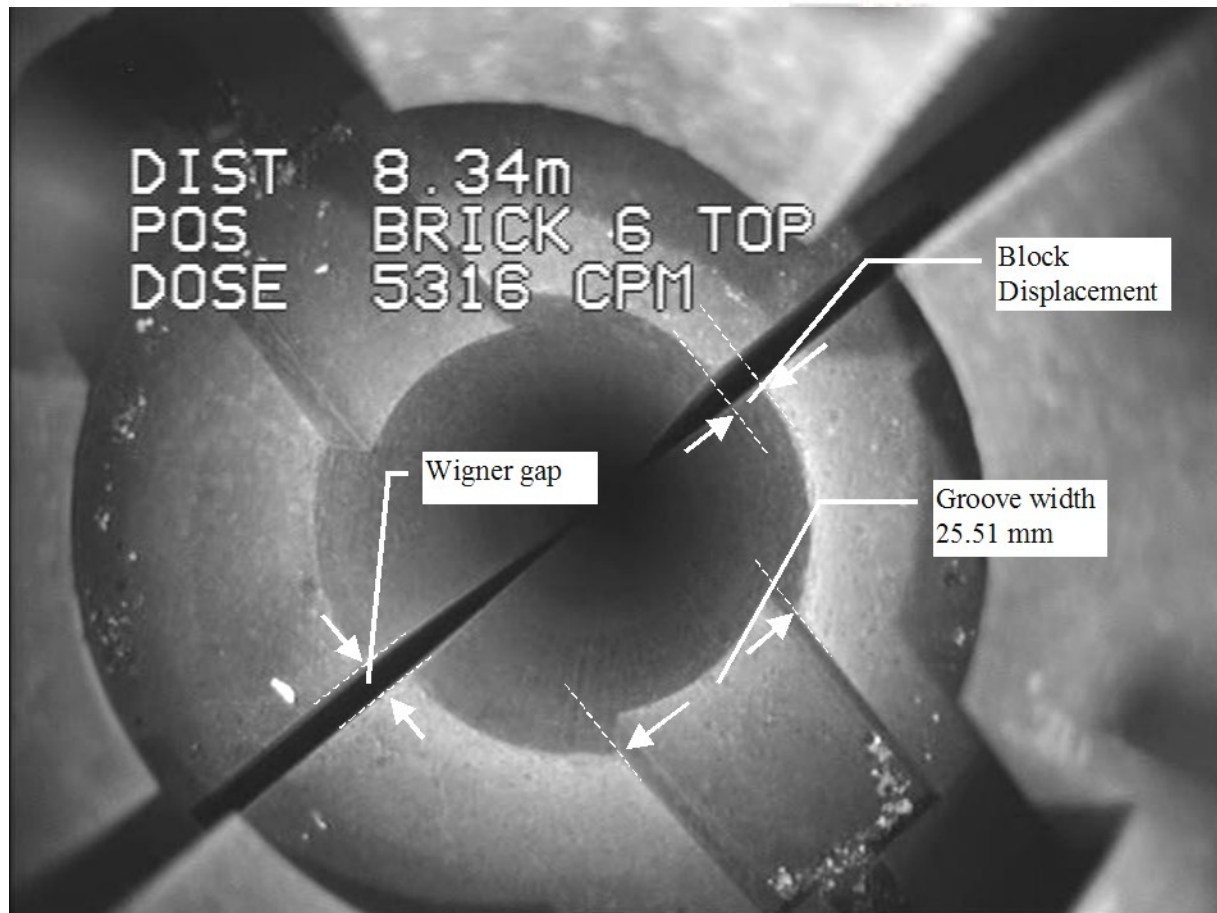


The monitoring and recording equipment

Pile 1 Foil Hole Inspections

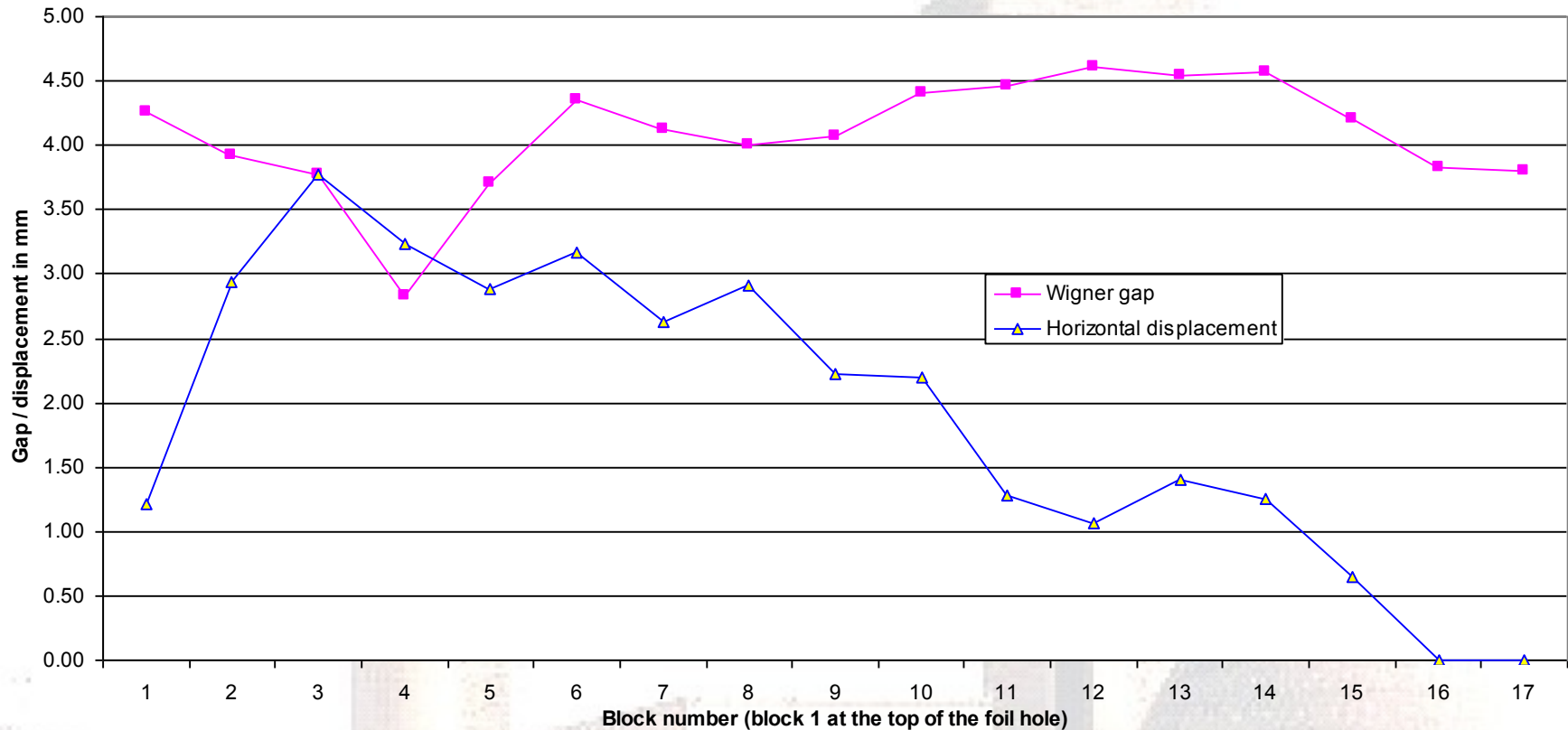
Dimensional change measurements

We were able to carry out checks on block displacements and Wigner gap sizes by using comparisons with the slit groove dimensions as shown in the following .



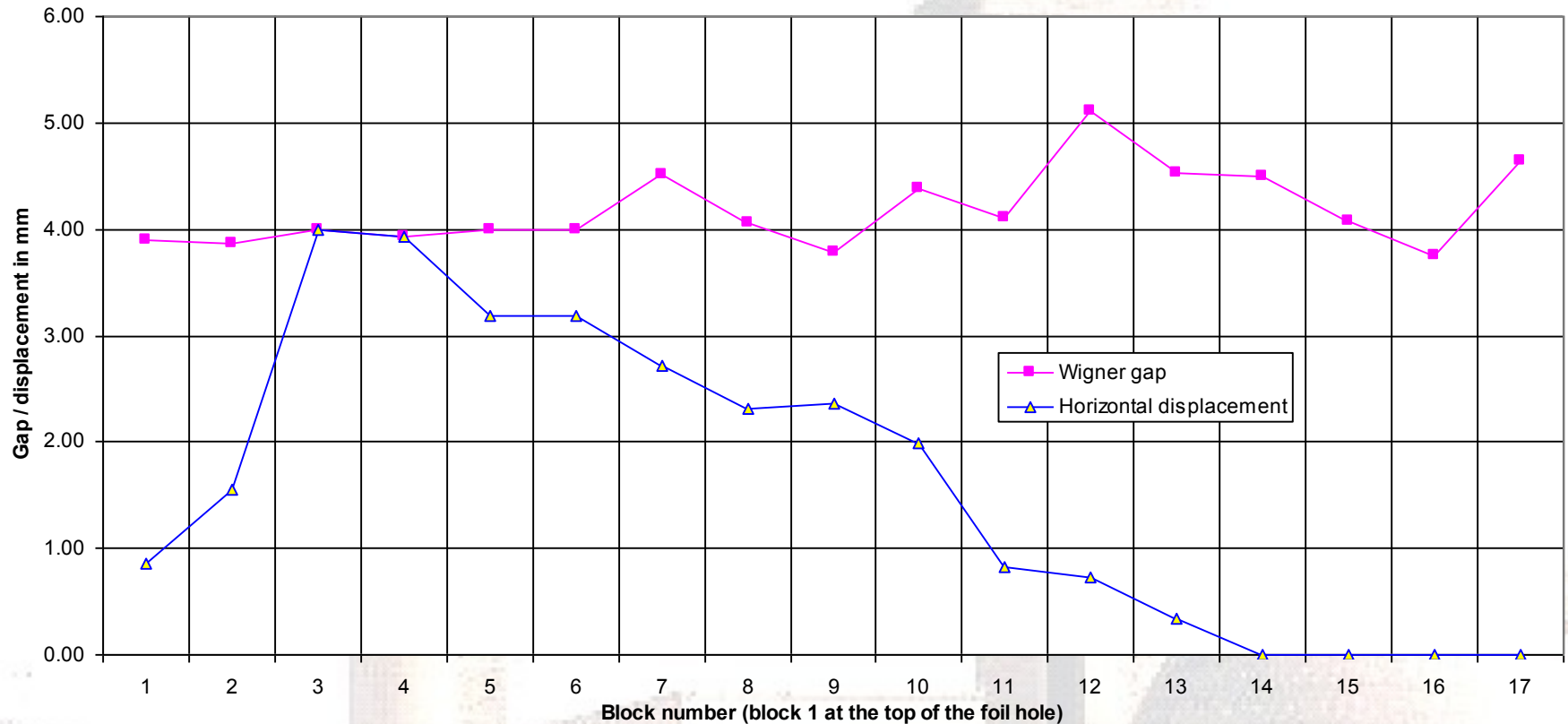
The top of core block 6 seen as the probe tip camera descends out of block 5 with annotation to show where measurements are take for Wigner gap and block displacement assessment.

Plot showing Wigner gap and horizontal displacement as assessed from photographs for the 17 foil hole 1 graphite blocks



Measured Variation in Block Sideways Displacement and Wigner Gap Width – foil hole 1

Plot showing Wigner gap and horizontal displacement as assessed from photographs for the 17 foil hole 9 graphite blocks

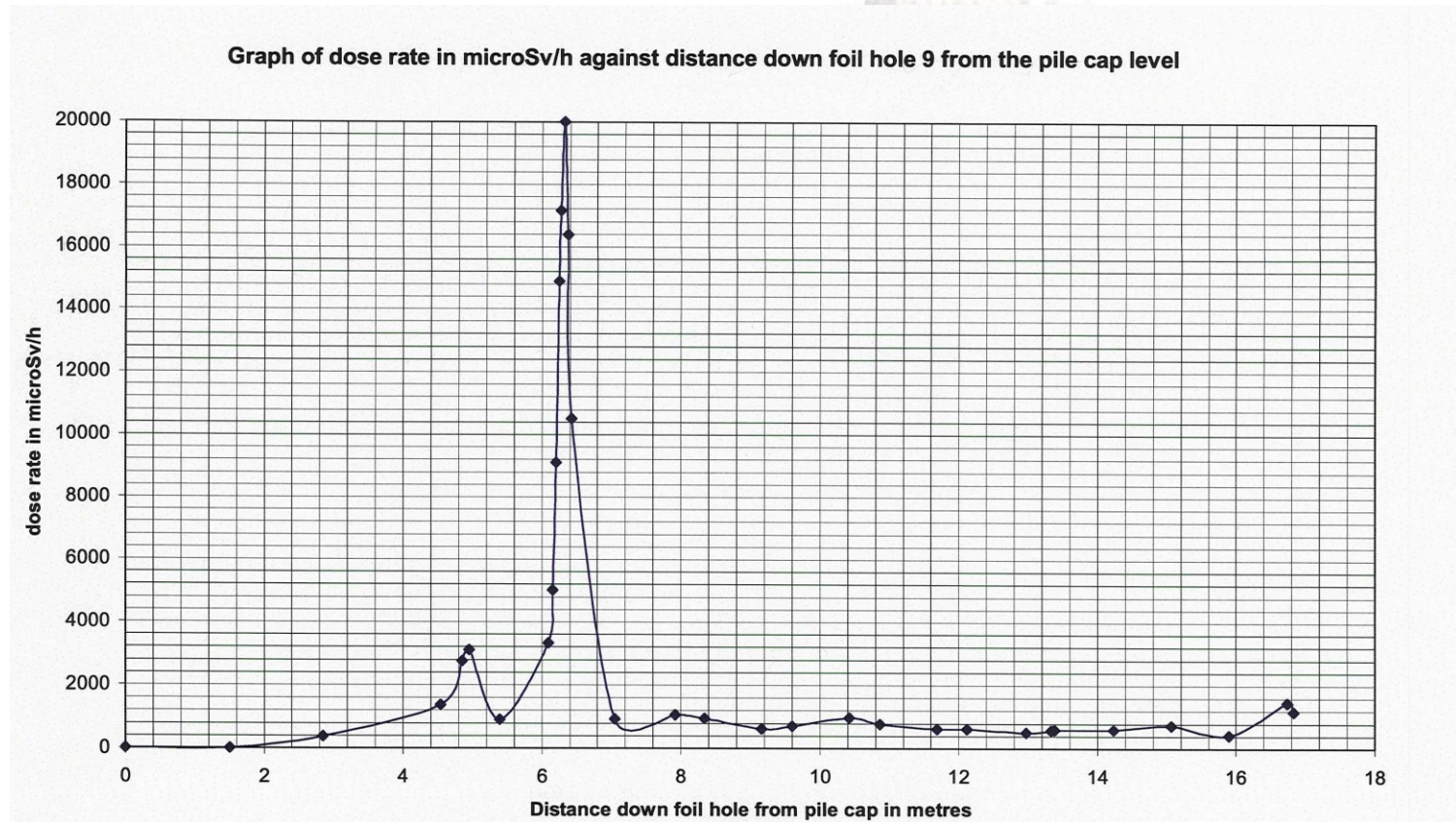


Measured Variation in Block Sideways Displacement and Wigner Gap Width – foil hole 9

Pile 1 Foil Hole Inspections

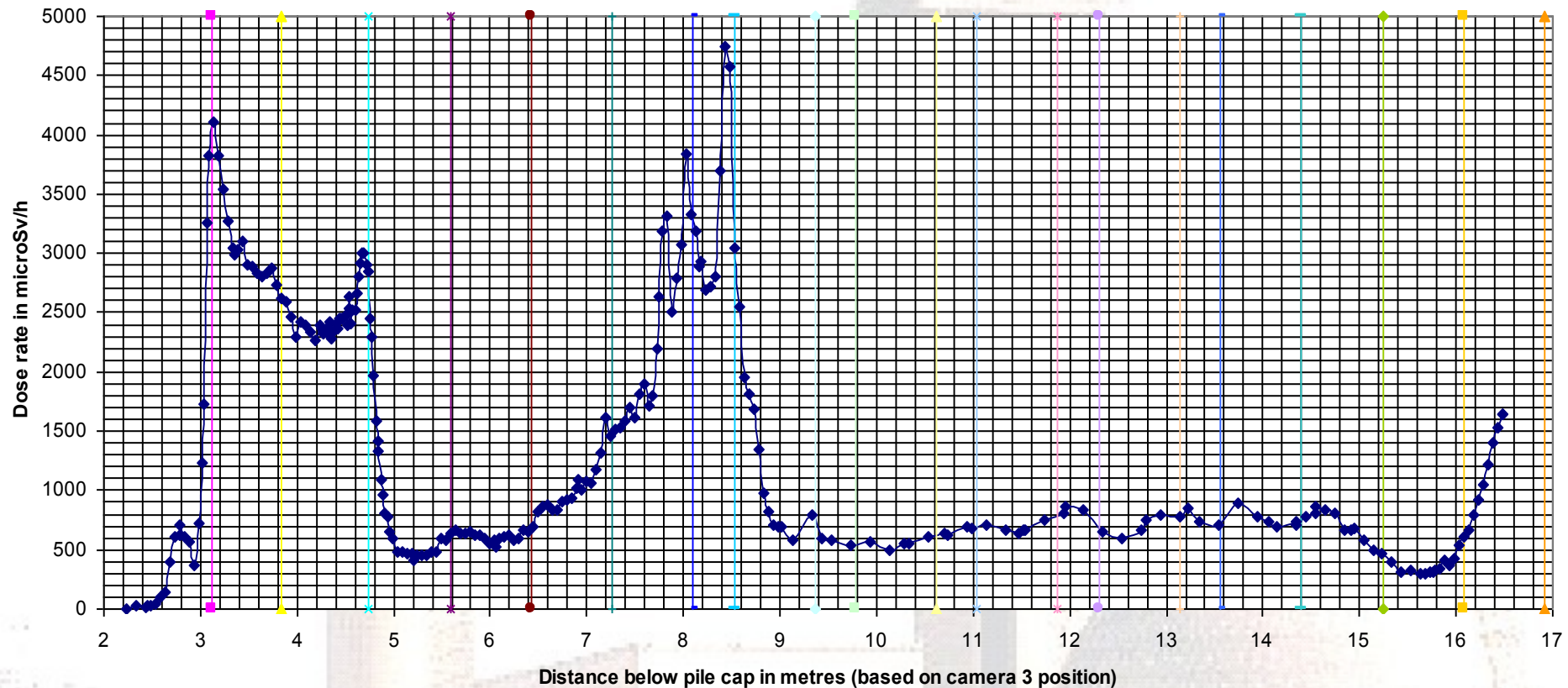
Dose rate measurements

A Geiger Muller Tube in the probe was used to measure the dose rate profile in the foil holes. Foil hole 1 has residual fuel in an adjacent channel the presence of which is clearly indicated in the following slide.



Dose rate profile down foil hole 9

Graph of dose rate in microSv/h against distance down foil hole 1 from the pile cap level.
The vertical bars show the positions of the graphite block layer interfaces.

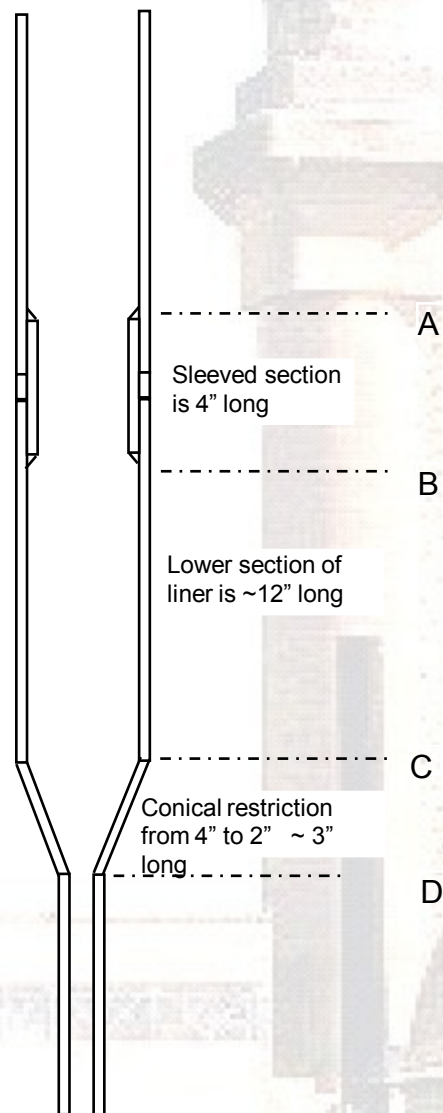


Dose rate profile down foil hole 1

Pile 1 Foil Hole Inspections

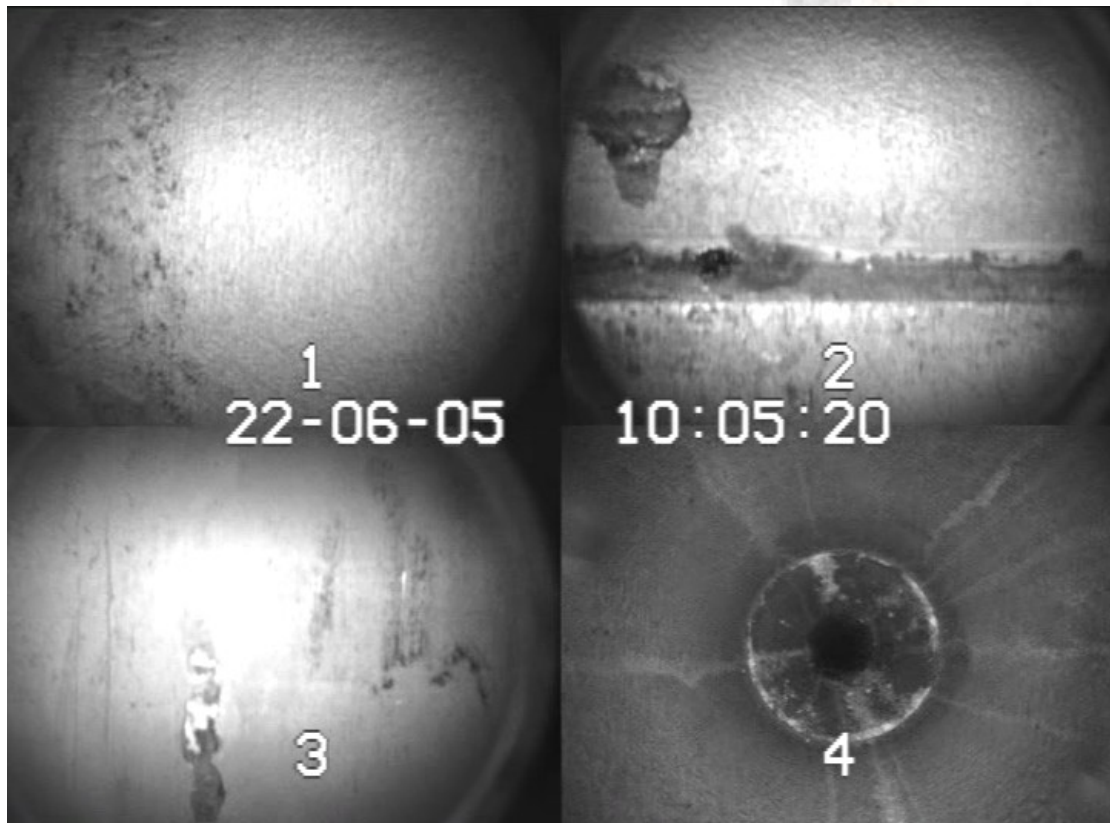
The following slides show some detail from a journey down one of the foil holes.

Make-up of top bioshield
liner as revealed by
inspections

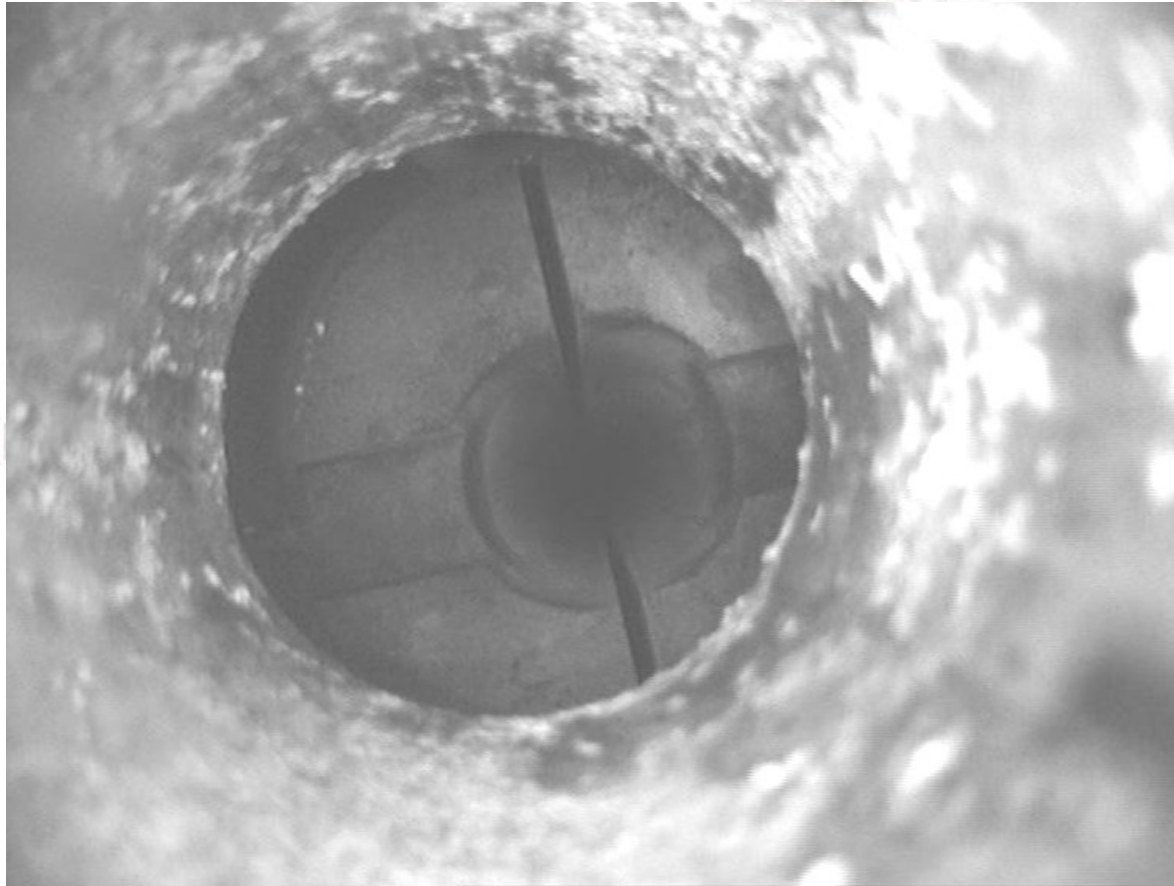




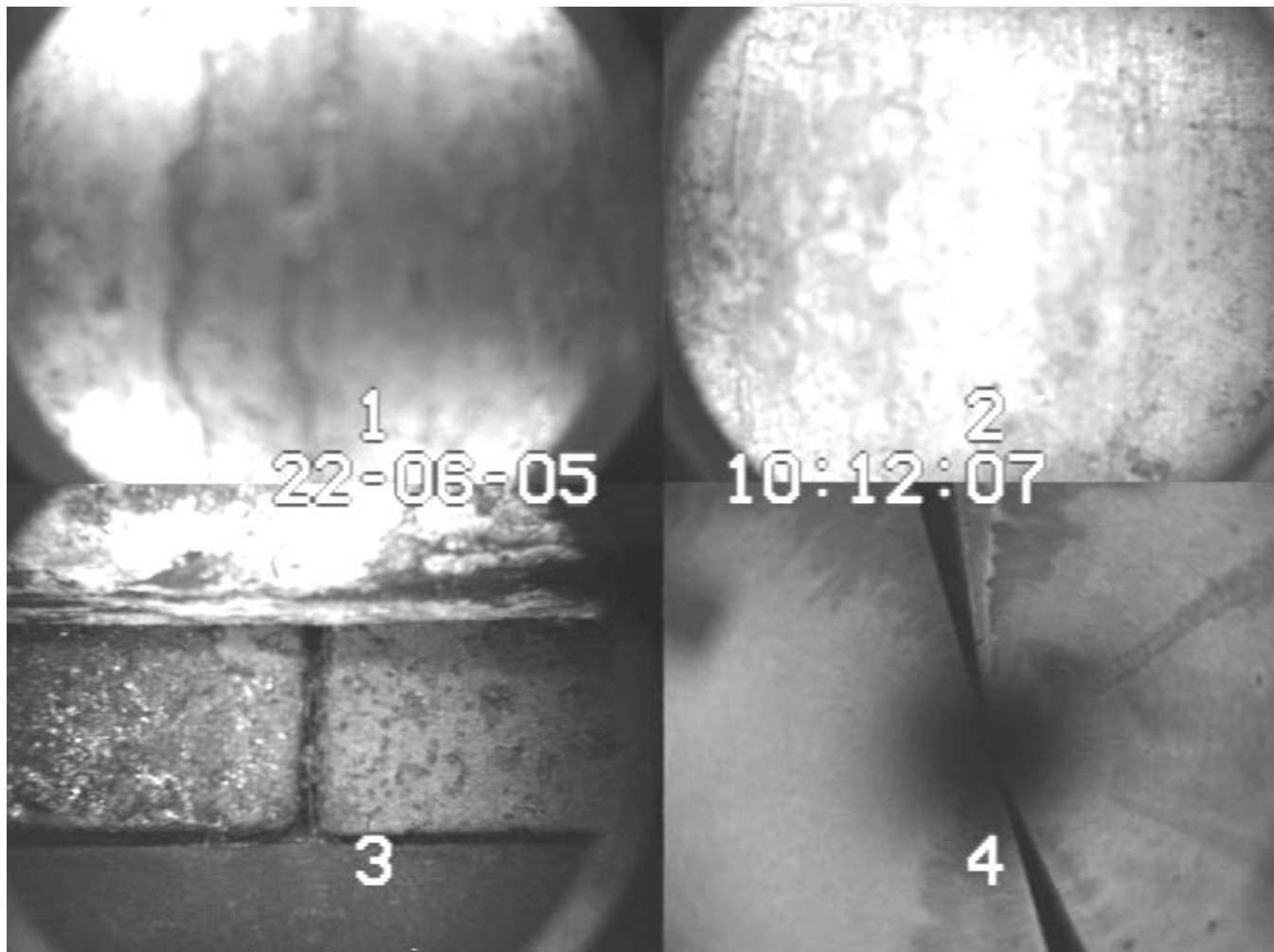
View of sleeve in bioshield tube foil hole 9



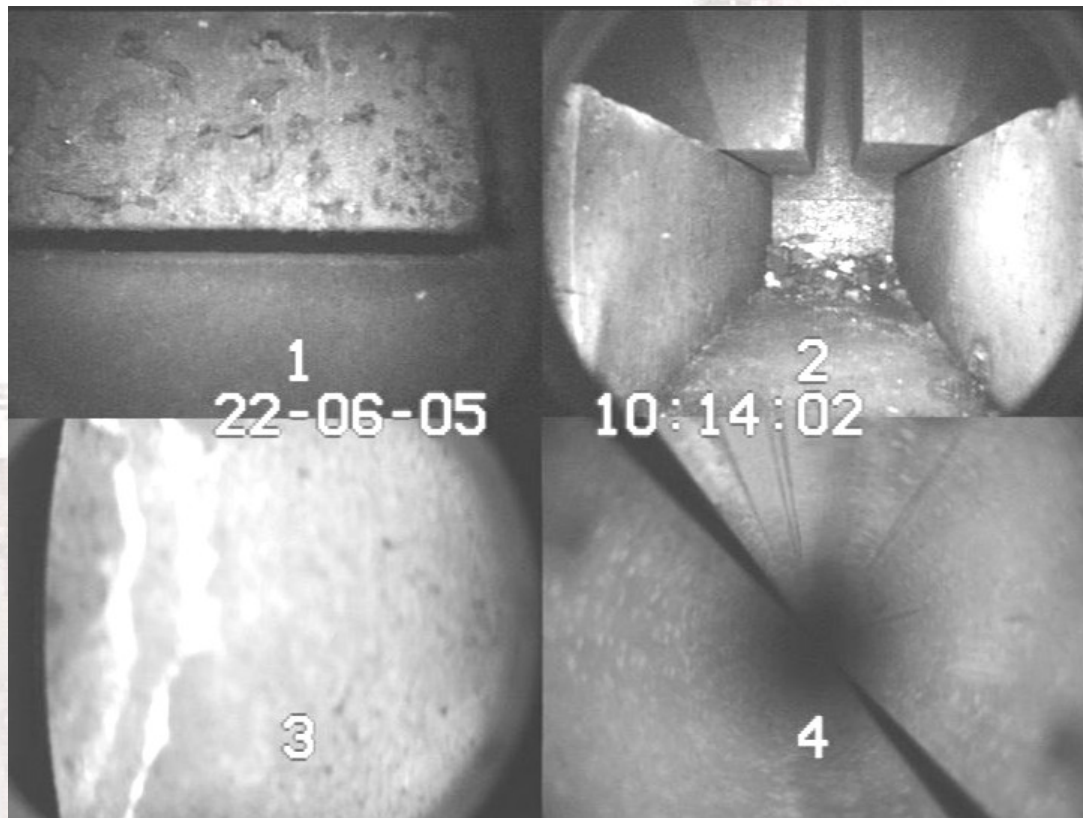
Top of inner sleeved joint in camera view 2 (Point A on the elevation sketch). Conical section can be seen coming up in the forward view



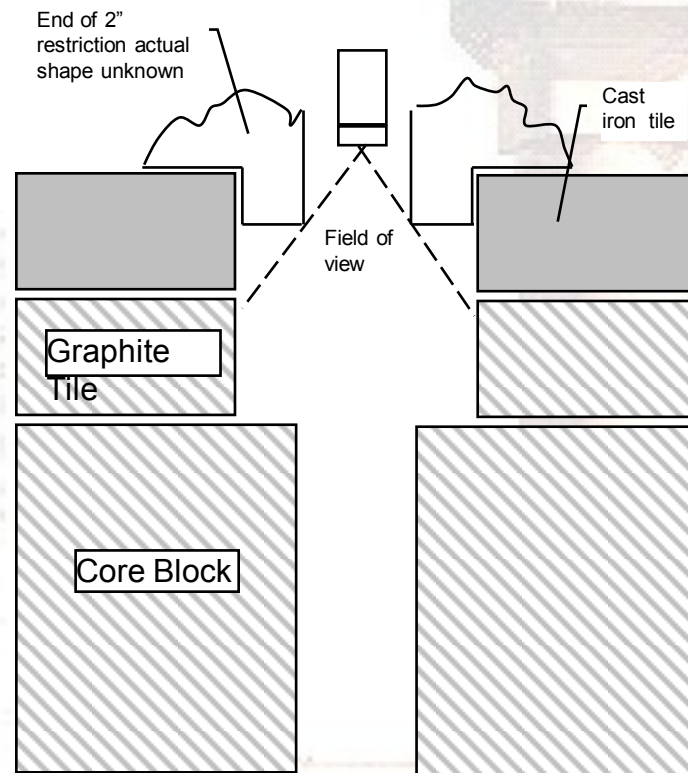
Top of core coming into view, camera probe at the bottom of the small bore tube section



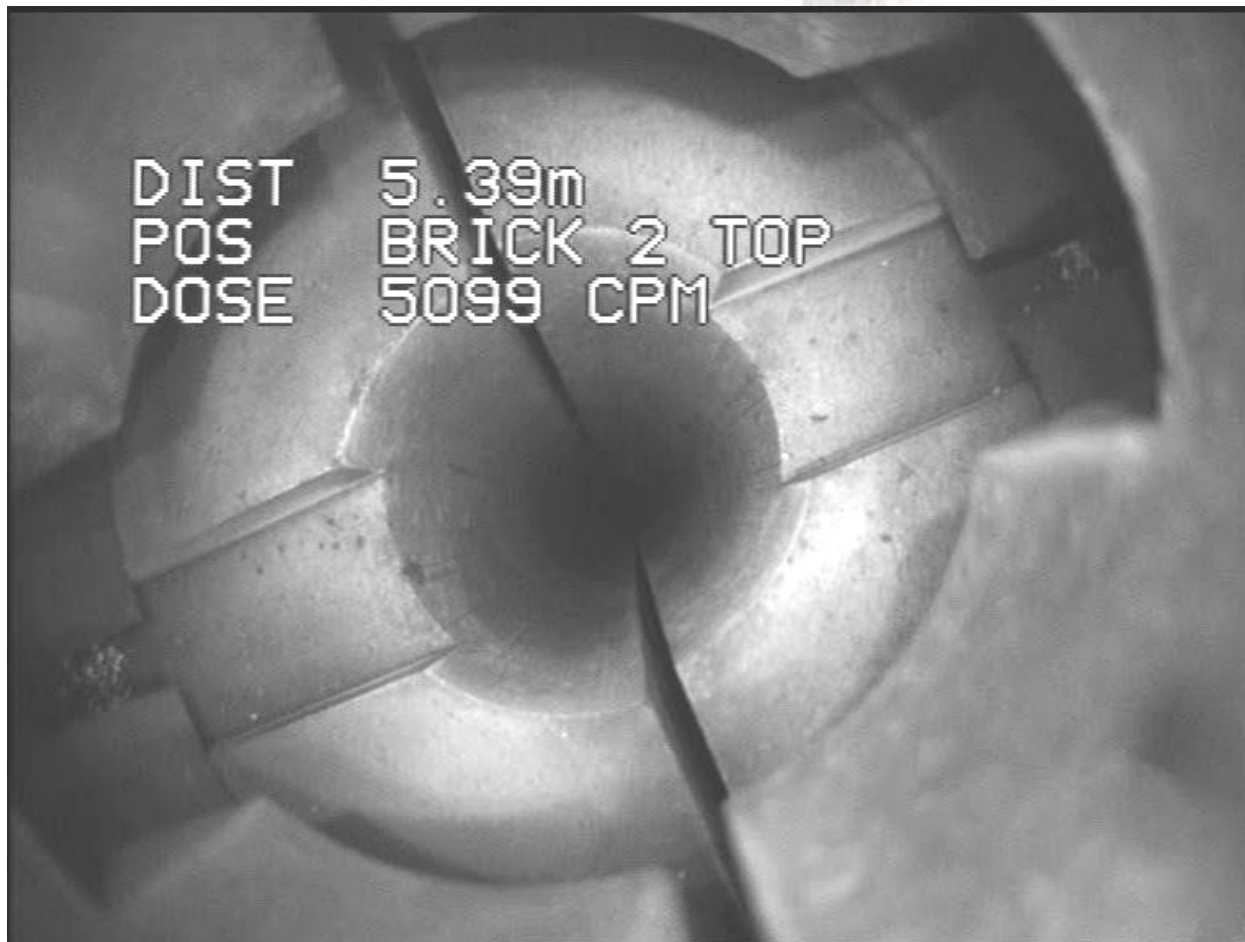
Side xamera 3 viewing the end of the liner tube section (top of picture) the cast iron top tile and the graphite block below



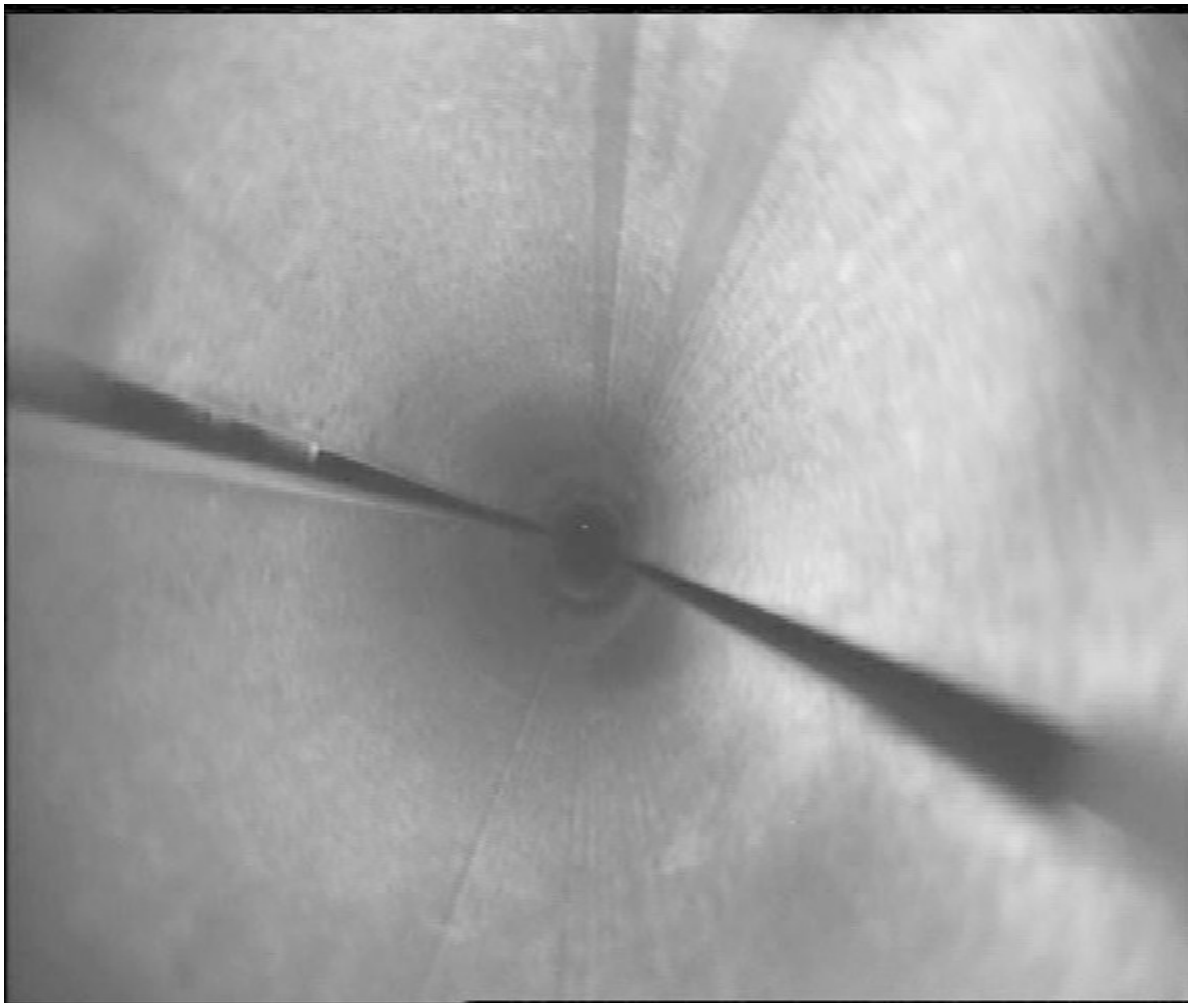
Camera view 1 shows the cast iron top tiles. Camera 2 shows the slot groove at the top of layer 1, the slot, and the graphite tiles. Some debris is present in the slot groove.



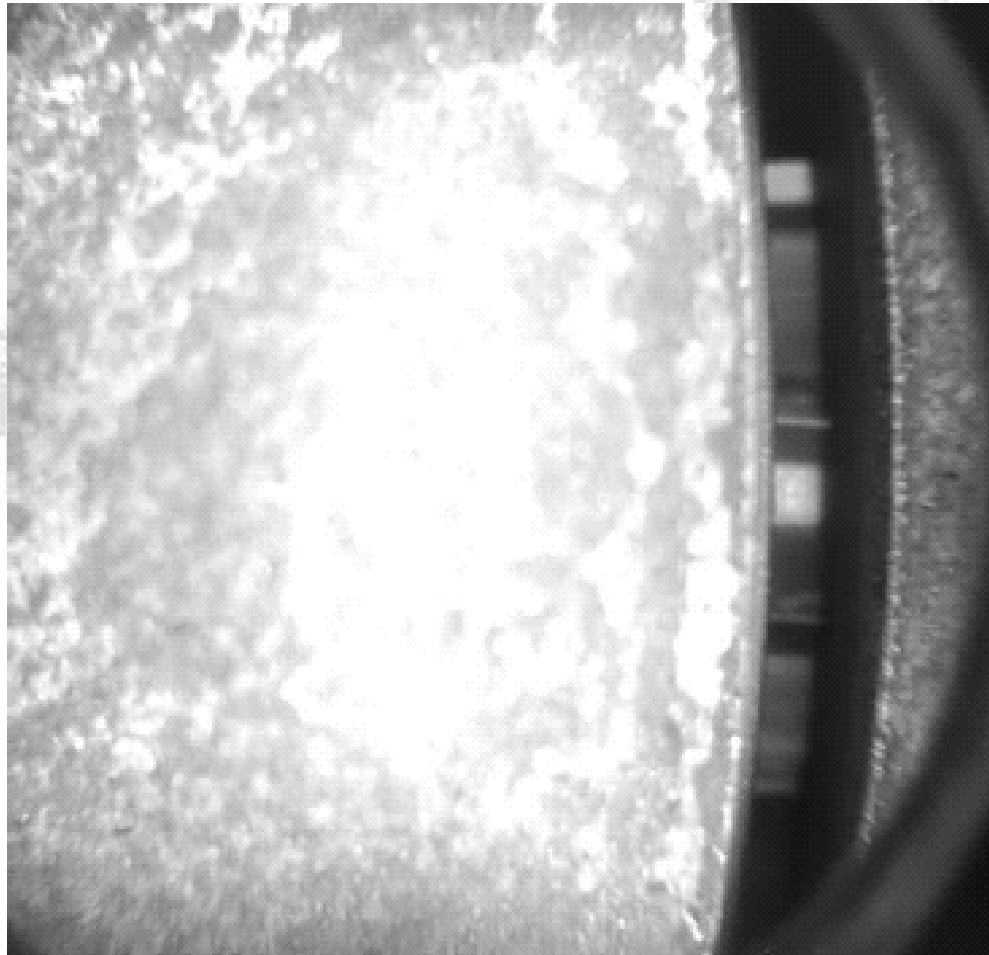
Presumed structure at the top of the core



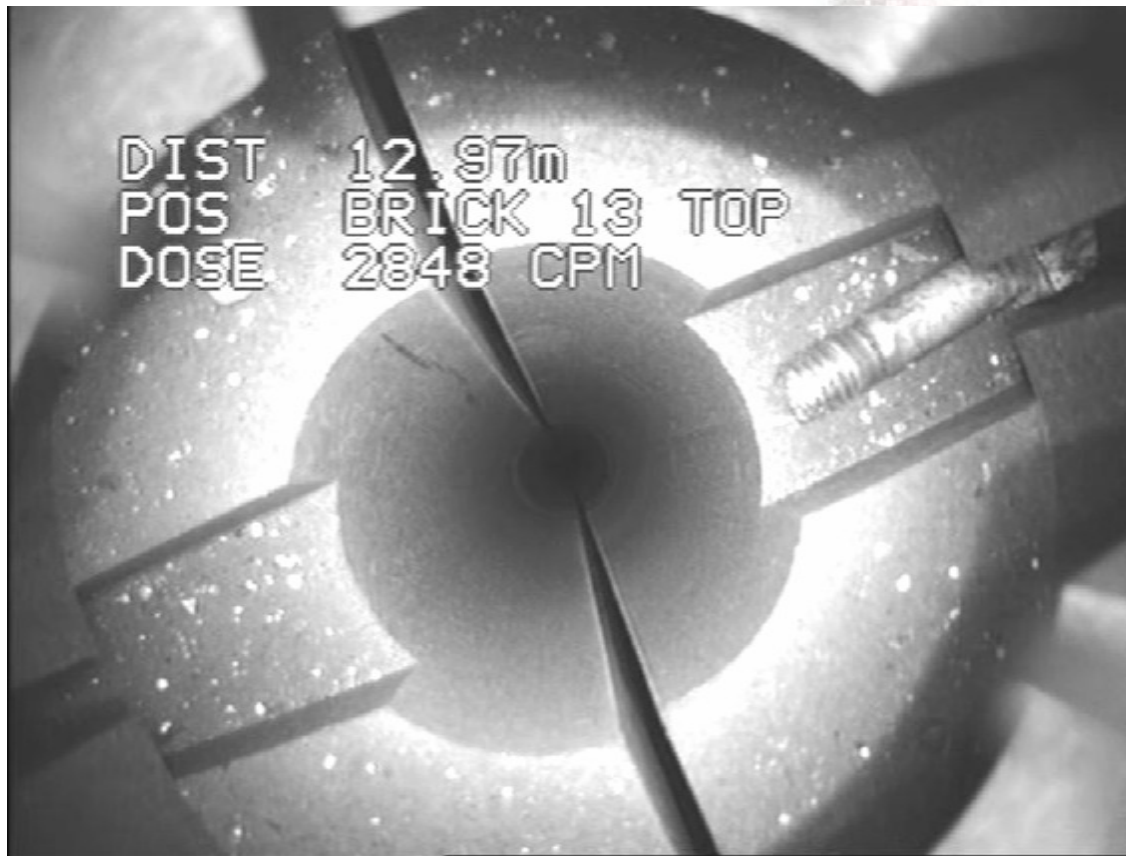
View of the top of brick layer 2 from the forward looking camera 4



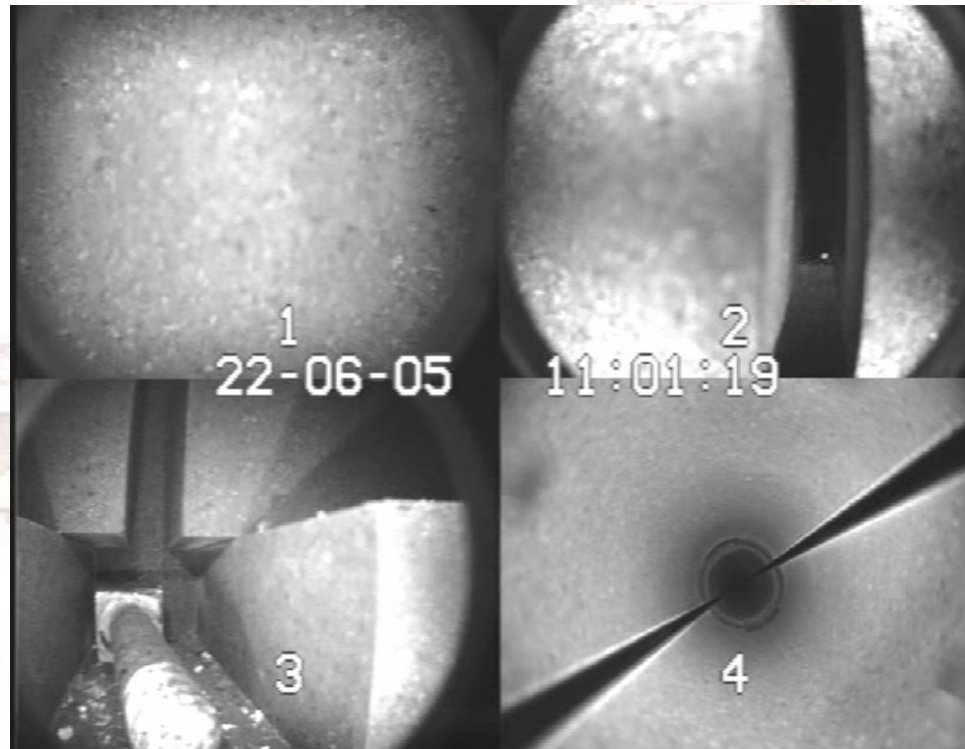
Front view camera 1 travelling through brick layer 2 of foil hole 9. Fuel can just be seen in the adjacent channel.



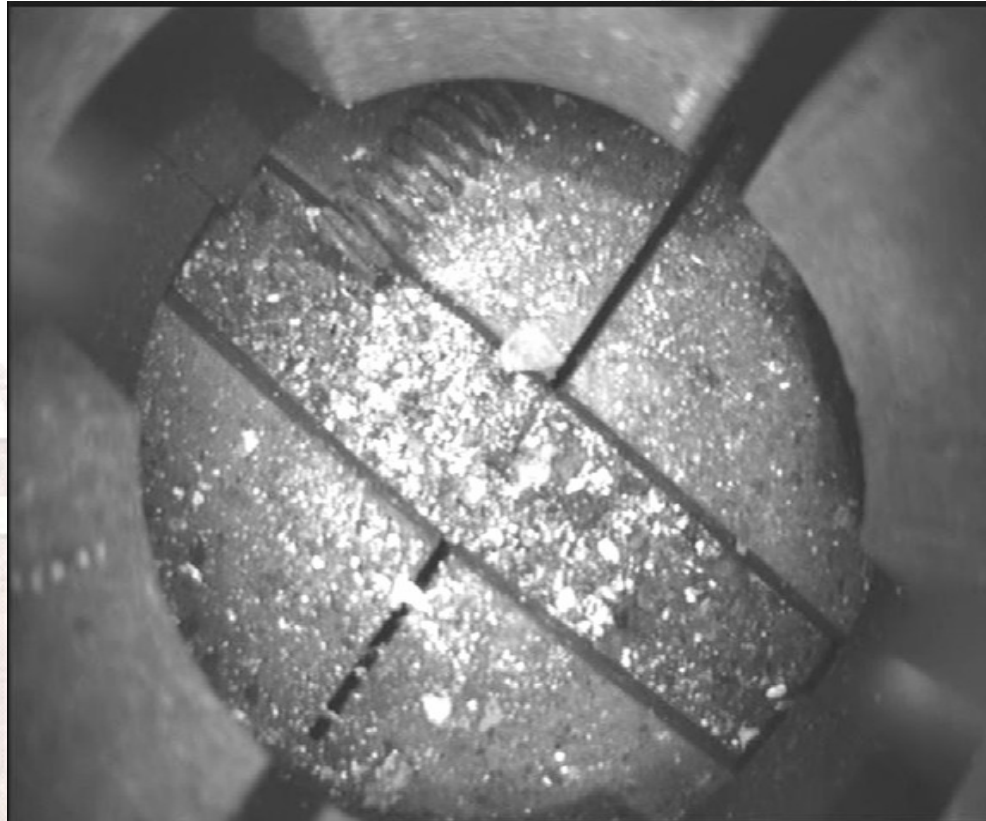
Fuel element visible in adjacent channel through the wigner gap between the two layer bricks which form the foil hole



Bolt on top of block 12 in a slat groove foil hole 9



Bolt on top of block 12 in a slat groove foil hole 9



Bottom FH9 at bottom of brick layer17

Pile 1 foil hole inspections

The overriding conclusions from these inspections are:

- **The graphite blocks which make up the foil holes inspected are in very good condition.**
- **The equipment is capable of providing much detail concerning the contents of adjacent channels both by views through the Wigner gaps and from dose rate measurements.**

Pile 1 foil hole inspections

The equipment is capable of making core temperature assessments, but it would be necessary to investigate the transient behaviour of the probe in the core. It will also be necessary to investigate separately the relationship between air flow, air temperature and adjacent graphite temperature within the core before making a decision on the interpretation of the probe ambient temperature reading.

Piles Graphite Inventory Assessments

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- **Modelling has been used in a similar manner to that used for the WAGR to generate graphite inventories based on the available compositional data for the material**

Piles Graphite Inventory Assessments

**Graphite elemental make-up
used in flux modelling**

Element	Mass fractions
N	0.77 ppm
Fe	25 ppm
Mn	0.7 ppm
Ni	20 ppm
Cr	10 ppm
Si	100 ppm
Mo	0.27 ppm
Al	20 ppm
C	999500 ppm
B	0.96 ppm
Ca	300 ppm
Pb	0.3 ppm

Piles Graphite Inventory Assessments ppm levels used in activations

Element	ppm	Element	ppm
Li	0.046	Co	0.3
Be	0.2	Ni	20
B	0.096	Zn	1.5
C	1E6	Mo	0.27
N	10	Ag	0.02
Na	3	Cd	0.04
Mg	3	In	0.047
Al	20	Sn	0.3
Si	200	Ba	5.4
S	52.9	Sm	0.04
Cl	2	Eu	0.01
Ca	300	Gd	0.005
Ti	18	Dy	0.008
V	190	W	0.69
Cr	10	Pb0.3	0.004
Mn	0.7	Bi	0.08
Fe	25		

Piles Graphite Inventory Assessments

**Calculated and Measured Core
Graphite Activities in Bq/g
in 2001**

Isotope	Calc. Bq/g	Meas. Bq/g
Co-60	1.43E+03	2.80E+02
Fe-55	7.35E+01	
Ni-59	5.11E+03	
Ni-63	4.72E+03	
Mn-54	8.08E-07	
Nb-94	4.34E-05	
C-14	2.64E+04	2.15E+04
H-3	7.79E+04	9.04E+04
Eu-152	1.73E+00	2.97E+01
Eu-154	2.59E+03	5.56E+01
Eu-155	3.83E+02	
Cl-36	4.87E+02	7.92E+00
Ca-41	2.26E+02	